CHAPTER 2
DISTANCE DETERMINATION

In conventional survey operations, a primary requirement of the survey party is to determine distance between two points. The surveyor has many devices available with which to determine distance. These range from the 30-meter steel tape to electronic instruments. Using the solution of geometric figures by methods such as trig traverse is discussed in Chapter 5. Distance measurement is a basic operation that every FA surveyor must be able to perform with the tools available.

Section I

HORIZONTAL TAPING

Horizontal taping is used in conventional FA surveys. In this method, all measurements are made with the tape held horizontally. Measure the horizontal distance between the rear station and the forward station. Usually the distance between stations is more than a full tape length. The taping team determines the distance by measuring successive full tape lengths. When the distance remaining is less than a full tape length, the team measures the partial tape length. The total distance between the stations is determined by multiplying the number of full tape lengths by the length of the tape and adding the partial tape length.

2-1. TAPING TEAM

A taping team consists of two men—a front tapeman and a rear tapeman. The rear tapeman commands the taping team and records all distances in his taping notebook. He is responsible for determining and reporting the measured distance to the recorder. The front tapeman independently computes the distance measured. Then he compares his findings with those of the rear tapeman and records the distance in his notebook. At night, taping requires additional personnel to assist the front and rear tapemen (paragraph 2-18).

2-2. TAPES AND ACCESSORIES

a. Survey taping teams are equipped with 30-meter steel tapes for measuring linear distances. Tapes are graduated on one side in meters, decimeters (0.1 meter), and centimeters (0.01 meter). The first decimeter is graduated in millimeter (0.001 meter). At each end of the tape is a blank space. Each tape is assigned a number that is used for all records about that specific tape (for example, repairs [paragraph 2-20b]).

b. In addition to a tape, each team is equipped with the following (Figure 2-l):

Ž One set of taping pins.

• One tension handle.

• One clamping handle.

Ž Two plumb bobs.

Ž Two pin and plumb bob holders.

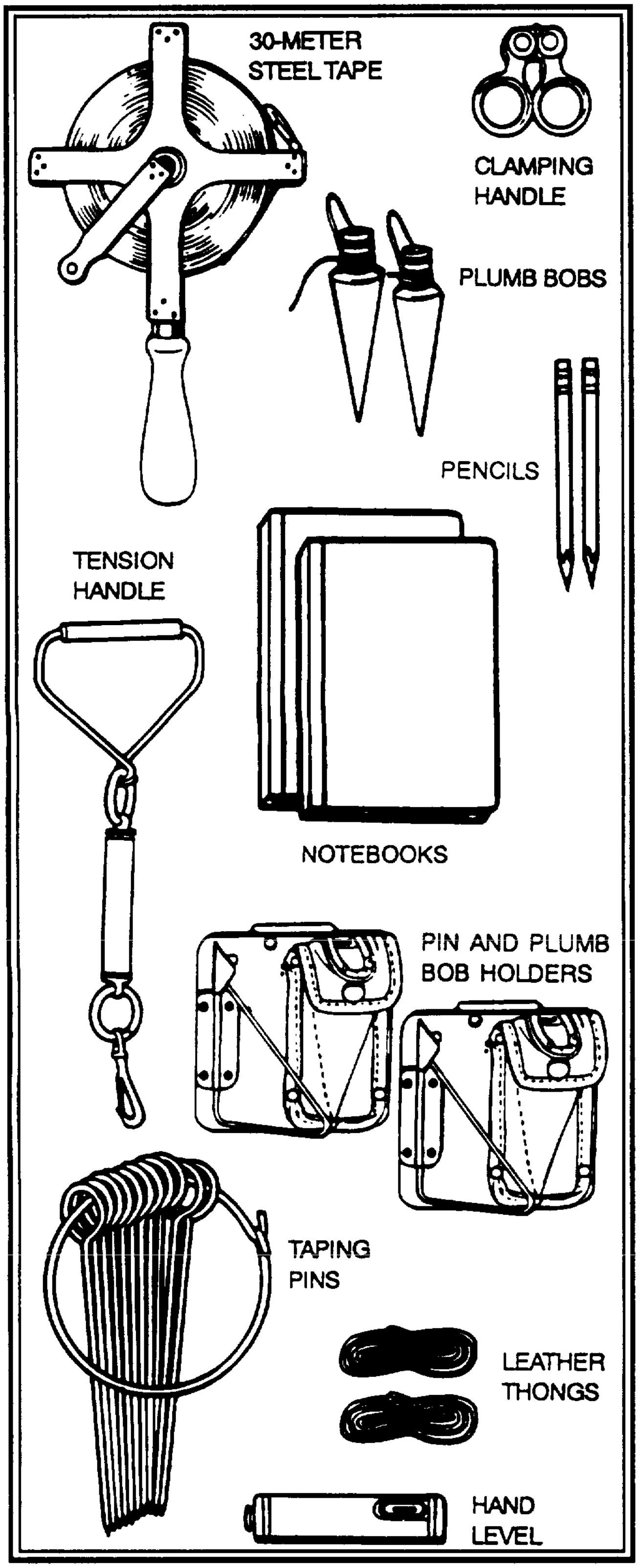
• One hand level.

• Two leather thongs.

• Two notebooks.

• Two pencils.

Figure 2-1. **Taping equipment**



(1) Taping pins. A taping pin is a steel pinpointed on one end with a ring at the other. Use taping pins for marking measured tape lengths on the ground. This will help determine the number of tape lengths measured since the last station. The ring and the upper part of the pin are painted red. The rest of the pin is white. Taping pins are issued in sets of 11 pins each. Properly used, taping pins will prevent a "missed" or "dropped" tape length, a common mistake in distance taping.

(2) Tension handle. The tension handle is used to train taping personnel to recognize when 25 pounds of tension is exerted on a tape. Do not use it in normal everyday surveys. The tension handle has a linear scale graduated in pounds from 0 to 30. Clip it to the tape loop at the end of the tape. Apply tension until the specified reading (25 pounds for artillery survey) appears on the scale.

(3) Clamping handle. This is a mechanical device that grips the flat steel tape without causing a kink in it. When measuring less than a full tape length, the clamping handle permits holding the tape while applying tension.

(4) Plumb bobs. Plumb bobs are used to transfer tape readings to a ground position. This will allow the tape to be read directly above a marked position on the ground.

(5) Pin and plumb bob holders. Each tapeman uses a pin and plumb bob holder to carry taping pins during taping operations. Store the plumb bob in the holder when taping operations are not performed.

(6) Hand level. Use the hand level when taping distances over steep slopes to help keep the tape on a horizontal plane. Use it in normal taping operations to train new tapemen to recognize the required horizontal plane.

(7) Leather thongs. Attach a leather thong to each end of the tape. The leather thongs allow the tapemen to apply tension to the tape.

(8) Notebooks and pencils. Each tapeman keeps a notebook to record distances between stations. These notebooks are in addition to the recorder's notebook.

(9) Other equipment. Often, taping will require the use of other equipment. To get a straight-line clearance between taping points, tapemen may have to clear away vegetation. Useful cutting tools, such as axes, hatchets, or machetes, may be issued to the taping team. Use range poles for aligning the tape from station to station. When measuring distances at night, use flashlights to help align the tape.

2-3. TAPE ALIGNMENT

a. The tapemen must carefully align the tape. The maximum allowable error in both horizontal and vertical alignment is 0.5 meter from one station to the next. The rear tapeman usually makes final alignment by sighting along the tape toward the forward station. The rear tapeman will direct the front tapeman left or right. (See Figure 2-2.) However, if the rear tapeman cannot see the forward station, the front tapeman will make the final alignment. This is done by sighting back on the rear station. The rear tapeman, using preselected reference points aligned with the forward station, can also make the final alignment. The instrument operator, if available, may help in the alignment.

b. The tapemen then level the tape horizontally by holding it parallel to an estimated horizontal plane. If they have trouble keeping the tape level in rough terrain, the tapemen should use the hand level. To use the hand level to set a horizontal plane, the downslope tapeman takes the steps below.

(1) Sight through the level at the upslope tapeman.

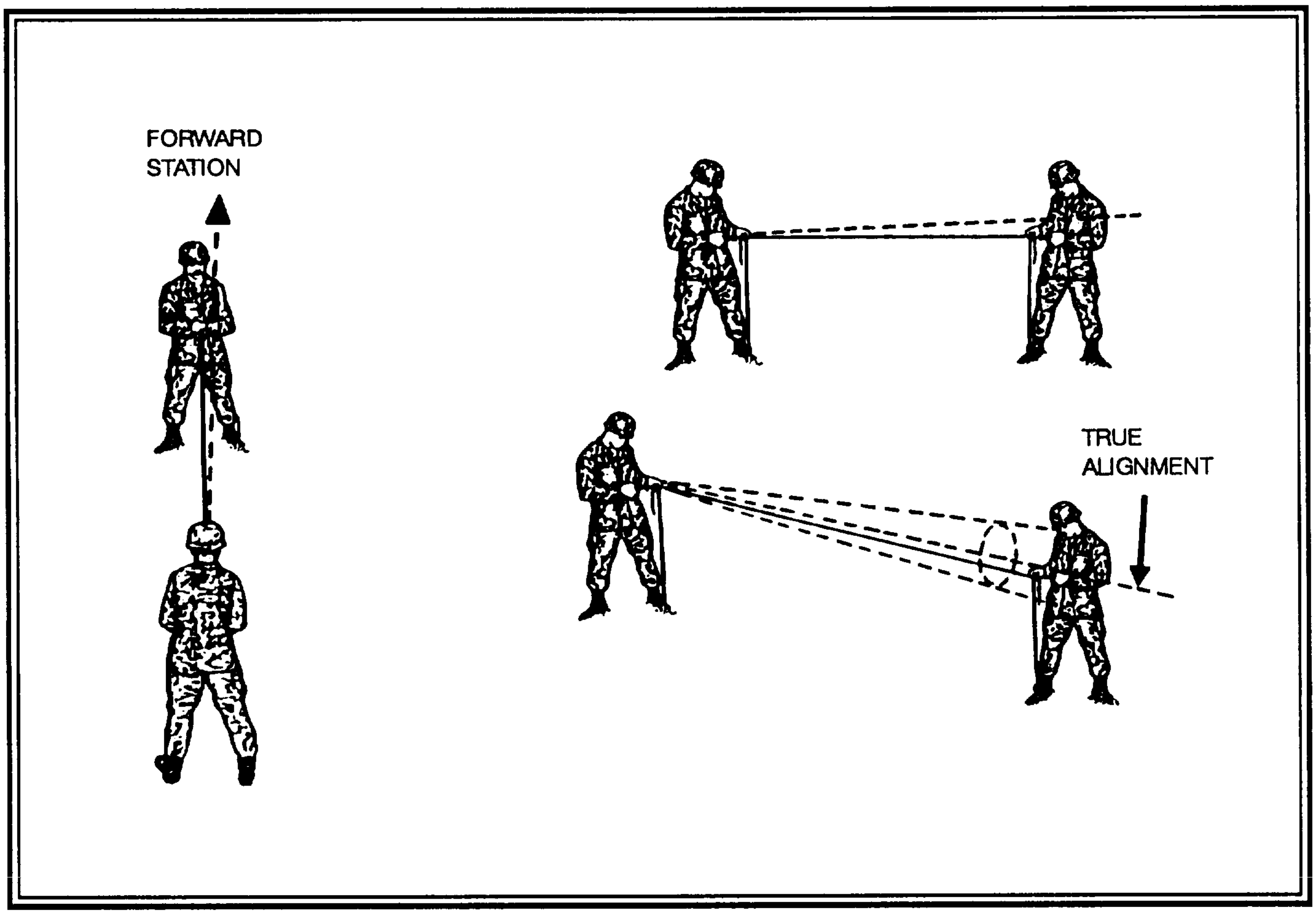
(2) Raise or lower the objective end of the hand level until the image of the level bubble is centered on the horizontal crossline.

(3) Determine the point on the upslope tapeman that is level with the eye. This establishes the horizontal plane.

(4) Tell the upslope tapeman how to hold his end of the tape so that the tape will be parallel to the established horizontal plane. The downslope tapeman must hold the tape no higher than his armpits. Otherwise, the team must use the breaking tape procedure.

c. The tapemen should check the accuracy of the bubble of the hand level when it is first used each day. The upslope tapeman uses the hand level to sight on the downslope tapeman to establish the horizontal plane. The procedure is then reversed to verify the established horizontal plane.

Figure 2-2. **Tape alignment**



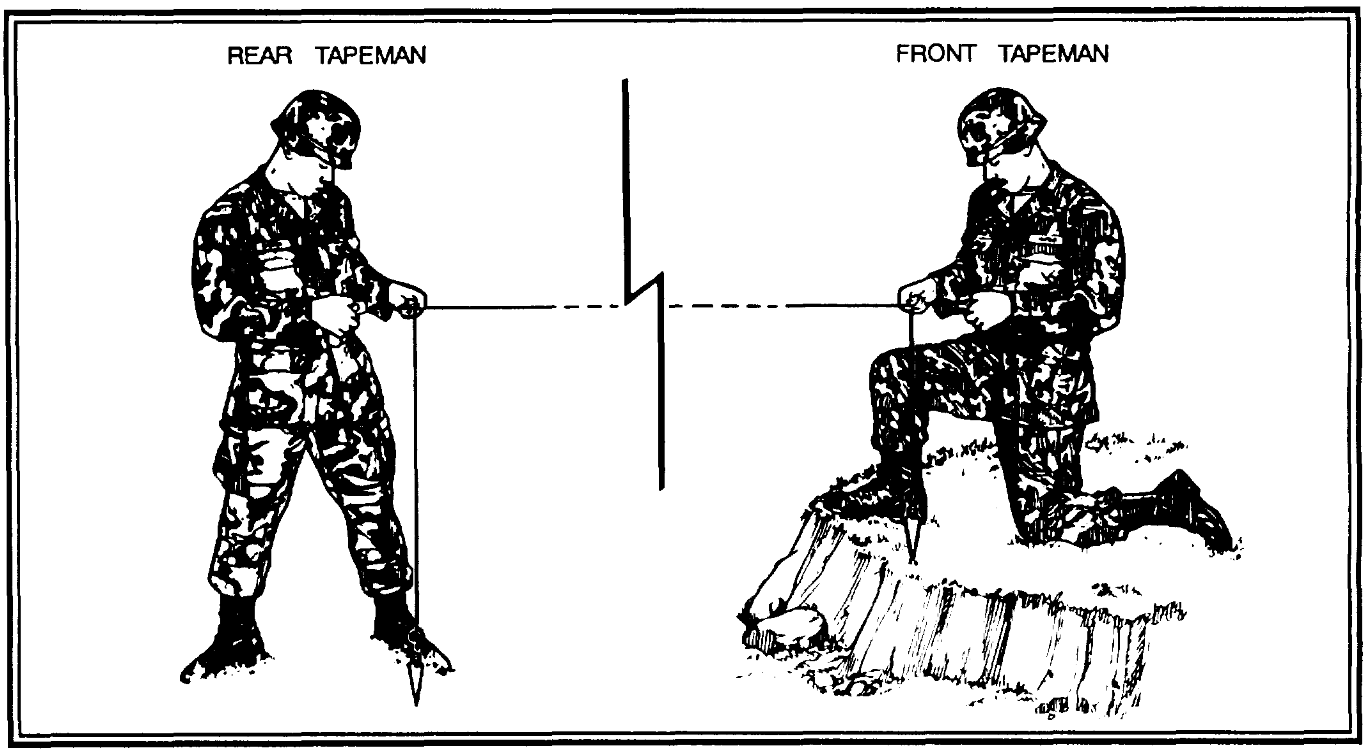
2-4. APPLYING TENSION TO TAPE

a. The tapeman must apply 25 pounds of tension (pull) to each full or partial tape length. He should apply tension to the tape by using his leg muscles and the large muscles of his back. To do this, the tapeman faces across the tape with his shoulders parallel to the length of the tape. He then passes the hand of the arm that is away from the other tapeman through a loop in the thong. Then he places the elbow of that arm tight against some part of his body. (See Figure 2-3.) When the tapeman is standing, he applies tension by bending the knee that is away from the other tapeman. This causes the weight of his body to push against the arm holding the tape. When the tapeman is kneeling, he applies tension by pushing the knee that is away from the other tapeman against the arm holding the tape.

b. The clamping handle is used to hold the tape at arty point other than a tape end. To avoid causing a kink in the tape, the tapeman should hold the clamping handle with the index and middle fingers. Normally, the handle will clamp as he applies tension to the tape. To apply more pressure, the tapeman applies pressure to the outside of the finger grip by using the thumb and ring finger.

c. The front tapeman should use the tension handle until both tapemen become accustomed to the application of 25 pounds of tension.

Figure 2-3. **Applying tension and use of plumb bobs**



2-5. USE OF PLUMB BOBS

a. The tapemen use plumb bobs to project points on the tape to the ground. Each tapeman holds the plumb bob cord on the proper tape graduation using the thumb of one hand on the cord and the forefinger of that hand beneath the tape. (See Figure 2-3.) The front tapeman has the 0-meter graduation and the rear tapeman has the 30-meter graduation. After aligning the tape and applying tension, each tapeman lowers the plumb bob by letting the cord slip across the tape. The tip of the plumb bob should be about 0.25 inch above the desired point. Swinging of the plumb bob is stopped by gently lowering the tape until the plumb bob tip touches the ground and then slowly raising the tape.

b. The rear tapeman uses his plumb bob to position his end of the tape directly over the point from which each tape length is measured.

c. The front tapeman establishes the point on the ground to which each tape length is measured by dropping his plumb bob. If necessary, the front tapeman should clear high grass or other debris in the immediate ground area near the point to be established. This will ensure a true plumb over the point and help the rear tapeman in moving forward. After establishing the point with the plumb bob, the tapeman marks the point with a taping pin.

2-6. USE OF TAPING PINS

The front tapeman must use the taping pins to mark points on the ground for each full or partial tape length. The front tapeman marks the point struck by the tip of the plumb bob by sticking a pin into the ground at exactly that point. The shaft of the pin is placed at an angle of about 45° to the ground and perpendicular to the length of the tape. When moving forward, the tapeman should not pull the tape through the loop of the taping pin. In taping over a hard surface, it may be necessary to mark the point struck by the plumb bob in an identifiable fashion (point of taping pin). The point of the pin is laid at the point struck by the plumb bob, perpendicular to the line of direction of the tape.

2-7. MEASURING THE FIRST FULL TAPE LENGTH

Measure the first full tape length as discussed below.

a. The front tapeman gives 1 taping pin to the rear tapeman and keeps 10 pins. The pin given to the rear tapeman represents the first full tape length. The front tapeman moves toward the forward station with the zero end of the tape.

b. As the end of the tape reaches the rear station, the front tapeman stops, either on his count of paces or on the command **TAPE** given by the rear tapeman. The rear tapeman aligns the front tapeman by sighting first toward the forward station and then in an estimated horizontal plane. Align the tape within 0.5 meter of the line of sight from one station to the next and within 0.5 meter of the horizontal plane.

c. Each tapeman places a leather thong on his wrist and the plumb bob cord on the proper graduation on the end of the tape. The rear tapeman aligns his plumb bob roughly over the rear station and commands **PULL.** The tapemen exert a pull of 25 pounds on the tape.

d. After the tapemen have properly aligned and applied tension to the tape, the rear tapeman plumbs his end of the tape exactly over the rear station and commands **STICK.** At this command, the front tapeman drops his plumb bob and then marks the point of impact by inserting a taping pin into the ground. Insert the pin perpendicular to the line of measurement at an angle of about 45° to the ground. This allows accurate plumbing for the next measurement. After the pin is firmly placed, the front tapeman announces **STUCK.** This is the command for the rear tapeman to move forward to the pin position. The front tapeman advances 30 paces to measure the next tape length.

2-8. MOVING FORWARD

a. The front tapeman should select a landmark (rock, bush, or such) in line with the forward station. Use this technique as a guide in moving forward. The front tapeman should keep his eyes on the forward station. He should determine his pace count for one tape length. He can stop without signal from the rear tapeman when he has moved forward a tape length.

b. By moving forward to a point 2 or 3 meters forward of the rear end of the tape, the rear tapeman usually can locate the taping pin before the front tapeman has stopped. If the taping pin is not readily visible, the front tapeman may have to wait until the rear tapeman arrives at his position. Then he moves forward to make the next measurement.

c. When using an instrument at either the forward or the rear station, the tapeman must remain as clear of the line of sight as possible.

2-9. MEASURING SUCCEEDING FULL TAPE LENGTHS

Succeeding full tape lengths are measured as described in paragraph 2-7 except as discussed below.

a. The front tapeman should get his approximate horizontal alignment by sighting back along the tape toward the last pin position and the rear station. This will allow him to move right or left until the tape is about on line.

b. The rear tapeman plumbs the end of the tape exactly over the point at which the taping pin enters the ground.

c. After the front tapeman commands **STUCK,** the rear tapeman pulls the taping pin from the ground and then moves forward to the next pin position. If a taping pin is lost during the measurement of the distance, the tapemen must tape the entire distance again rather than complete the taping from a recovered pinhole.

2-10. BREAKING TAPE

When the tape alignment is unobtainable within 0.5 meter of a horizontal plane because of the slope of the ground, the tapemen use a special procedure known as breaking tape. (See Figure 2-4.) The procedure for breaking tape is discussed below.

a. The front tapeman pulls the tape forward a full length. He then drops it about on line and then walks back along the tape until he reaches a point at which a partial tape length can be measured. When the tape is held level, it should be no higher than the armpits of the downslope tapeman. At that point, the front tapeman selects any convenient full meter graduation. The tapemen then measure the partial tape length, aligning the tape and applying the full 25-pound tension. Clamping handles are used at any holding point between ends of the tape.

b. After he has placed the taping pin into the ground, the front tapeman announces **STUCK.** He then waits until the rear tapeman comes forward. The front tapeman tells the rear tapeman which full meter graduation was used; for example, **HOLDING 25.** The rear tapeman repeats **HOLDING 25.** The front tapeman receives a pin from the rear tapeman and moves forward. Tapemen repeat this procedure until they reach the zero mark on the tape.

c. When holding a point on the tape other than the zero graduation, the front tapeman must receive a pin from the rear tapeman before moving forward.

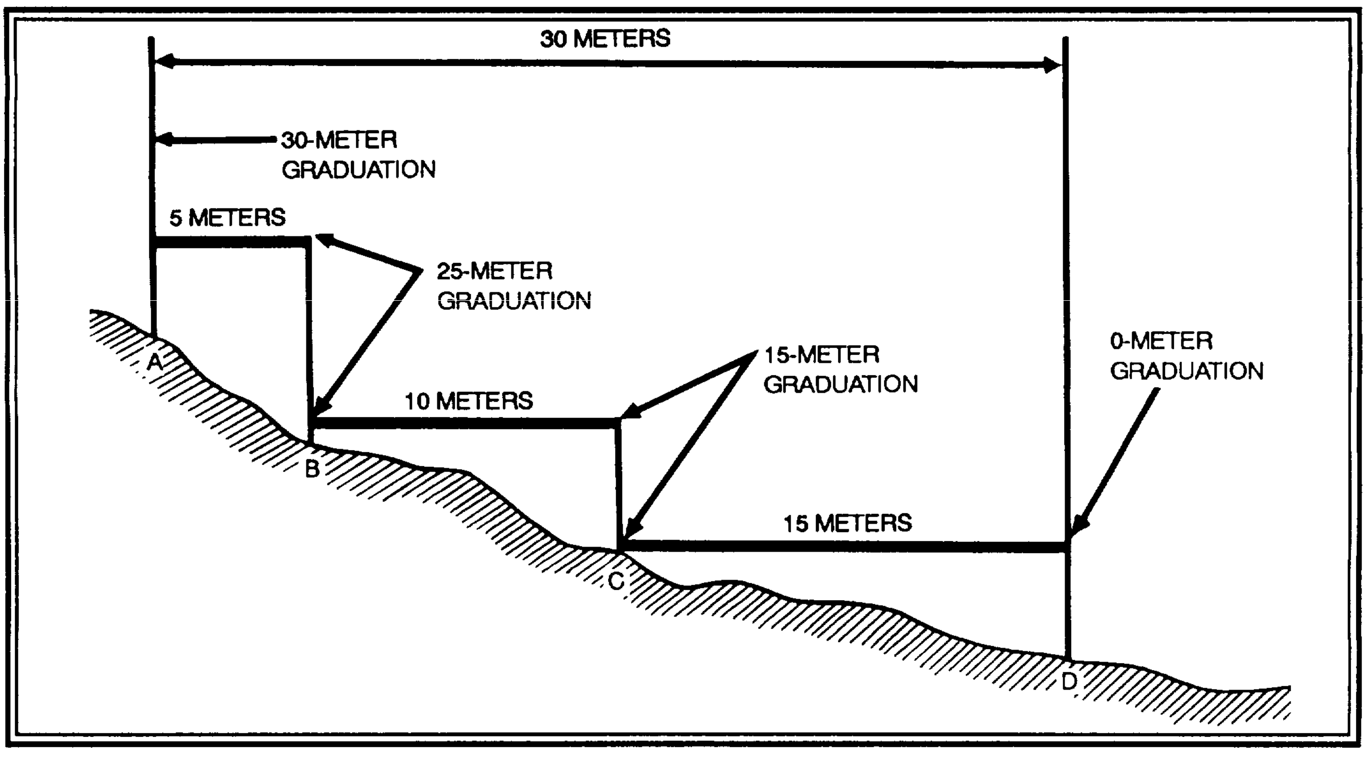
2-11. MEASURING DISTANCES MORE THAN 10 TAPE LENGTHS

To measure a distance longer than 10 full tape lengths, the tapemen use the procedures described in paragraphs 2-3 through 2-9 except as discussed below.

a. When the front tapeman has set his last pin in the ground, he has established a point that is 10 full tape lengths from the rear station. The front tapeman waits at the last pin position until the rear tapeman comes forward.

b. Both tapemen count the pins to be sure that none are lost. (One pin in the ground will not be counted. The rear tapeman should have 10 pins.)

Figure 2-4. **Breaking tape**



c. The rear tapeman gives the front tapeman the 10 pins.

d. Both tapemen record 10 tape lengths (300 meters) and then continue taping.

2-12. MEASURING PARTIAL TAPE LENGTHS

To measure the partial tape length between the forward station and the taping pin representing the last full tape length, the tapemen use the procedure discussed below.

a. The front tapeman moves to the forward station and places the plumb bob cord on the zero graduation of the tape. The rear tapeman moves forward along the tape to the taping pin.

b. To gain slack, the front tapeman commands **SLACK.** The rear tapeman allows the tape to move forward. When the front tapeman is ready, he commands **PULL.** The rear tapeman exerts a pull of 25 pounds on the tape, using a clamping handle to hold the tape. Then the rear tapeman slides his plumb bob cord along the tape until the plumb bob is exactly over the pin.

c. When the zero graduation is exactly over the forward station, the front tapeman commands **READ.** The rear tapeman reads the graduation marked by his plumb bob cord and announces the measurement of the partial tape length to the nearest 0.01 meter.

d. The front tapeman repeats the reading aloud, and both tapemen record the measurement.

e. If the survey party has a nonstandard tape that is graduated in millimeters (mm) from the zero end to the 1-meter mark and in decimeters from the l-meter mark to the 30-meter mark, or in any other combination, use the procedure discussed below.

(1) The front tapeman holds the plumb bob on zero.

(2) The rear tapeman, using a clamping handle to hold the tape, places his plumb bob cord on the first whole meter mark behind the last pin in the ground.

(3) The rear tapeman commands **PULL,** and the front tapeman exerts a pull of 25 pounds on the tape. The rear tapeman should give slack until his plumb bob is exactly over the last pin. The front tapeman slides his plumb bob cord along the tape until the plumb bob is over the forward station.

(4) When the rear tapeman's plumb bob (which he holds on a whole meter mark) is exactly over the pin, the rear tapeman commands **READ.** The front tapeman reads the graduation marked by his plumb bob cord and announces his partial meter reading. The rear tapeman announces the whole meter mark that he was holding.

(5) Computing independently, both tapemen subtract the front tapeman's partial meter reading from the rear tapeman's whole meter reading. After verifying the amputations by comparison, both tapemen record the distance.

EXAMPLE

Rear tapeman holding	20.00 meters
Front tapeman partial meter reading	-0.47 meter
Partial distance from last pin to forward station	19.53 meters
Full tape lengths measured = 7 (7 x 30)	+210.00 meters
Total measured distance	229.53 meters

f. When a taping team is making a measurement at a station occupied by an instrument, the tapeman can make the measurement at the plumb bob cord of the instrument. The tapeman must use extreme care not to disturb the instrument.

2-13. DETERMINING TAPED DISTANCE

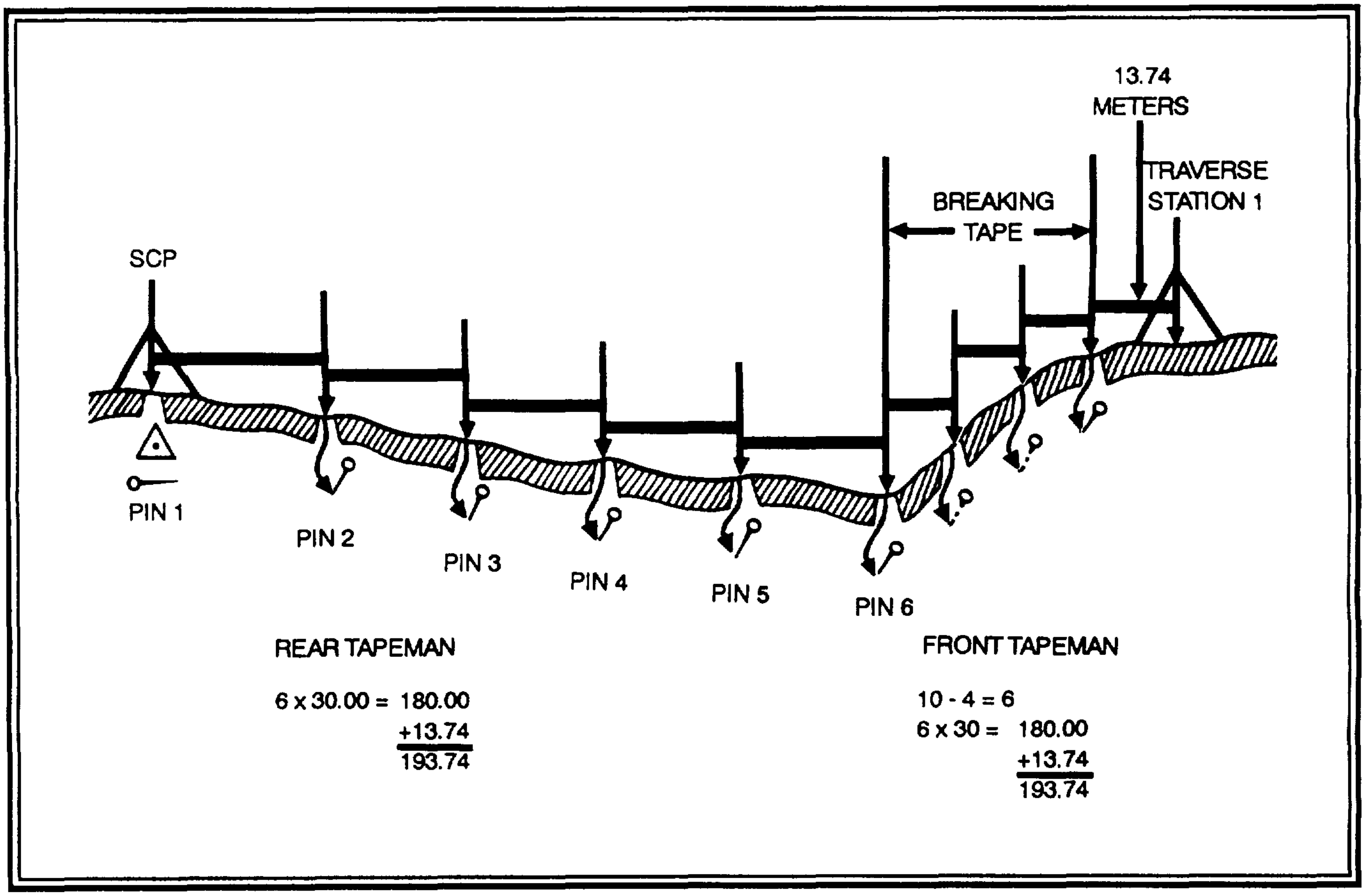
The tapemen determine and check the distance measurement (Figure 2-5) as discussed below.

a. Each tapeman counts the number of pins he has. (The pin in the ground at the last full tape length is not counted.)

b. The rear tapeman determines the distance measurement. He does this by multiplying the length of the tape (30 meters) by the number of pins in his possession and adding the partial length read from the tape.

c. The front tapeman independently checks the distance measurement. He does this by first subtracting the number of pins in his possession from 10, then multiplying by 30, and adding the partial tape distance.

Figure 2-5. **Determining taped distance**



2-14. USE OF TWO TAPING TEAMS

When two taping teams measure the distance between two stations, one taping team uses a pin to establish a starting station one-half tape length (15 meters) from the rear station. In this case, the front tapeman does not give a pin to the rear tapeman. The taping pin marking the half tape length represents one full tape length plus 15 meters. After establishing the starting station a half tape length from the rear station, the taping procedures are the same as those described earlier except that each tapeman adds 15 meters to the distance measurement. This procedure prevents both teams from placing their taping pins in the same hole.

2-15. COMPARATIVE ACCURACY FOR DOUBLE-TAPED DISTANCES

a. When the distance between two stations has been determined by double-taping, the two measurements are compared and the comparative accuracy of the two measurements is determined. The comparative accuracy is expressed as a ratio between the difference in the measurements and the mean of the measurements. The ratio is expressed with a numerator of 1; for example, 1/1000 or 1:1,000. The denominator is determined by dividing the mean of the measurements by the difference in the measurements. After the comparative accuracy is computed, the denominator of the fraction is reduced to the next lower hundred.

b. When the double-taped distance does not meet the required comparative accuracy, the distance must be taped a third time. Then the third measurement is compared with each of the first two measurements to determine if a satisfactory comparative accuracy can be achieved, with one or the other, The unsatisfactory distance is discarded.

EXAMPLE

Distance measurement by taping team 1	357.84 meters
Distance measurement by taping team 2	357.76 meters
Difference between measurements	0.08 meter
Mean of the measurements	357.80 meters

Comparative accuracy $= \frac{\text{Mean}}{\text{Difference}} = \frac{+\,357.80}{0.08}$

$= \frac{1}{4472.5}$ or $\frac{1}{4400}$

2-16. TAPING ACCURACIES

To achieve the various degrees of accuracy in survey, distances must be determined accurately to certain specifications, depending on the method of survey used. Prescribed accuracies for the different methods of survey are listed in Appendix B.

2-17. ERRORS

Horizontal taping errors fall into three groups-systematic errors, accidental errors, and errors caused by blunders.

a. Systematic Errors. Systematic errors are errors that accumulate in the same direction. They can be measured and normally are constant in each tape length.

(1) The systematic errors in horizontal taping cause distance to be measured longer or shorter than the true length. The main causes of systematic errors are as follows:

- Failure to align the tape properly.
- Failure to apply enough tension to the tape.
- Kinks in the tape.
- Tape of incorrect length (a little short or a little long).

(2) Eliminate systematic errors by strict adherence to proper procedures and techniques. Tapemen should be especially careful to keep the tape horizontal when taping on a slope and should break tape when necessary. They should avoid the tendency to hold the tape parallel to the slope. When taping in strong winds, tapemen must be especially careful to apply the proper tension to the tape. Tapes should be checked often for kinks. One of the chief causes of kinked tapes is improper use of the clamping handle.

(3) Systematic errors can be due to improper tape repair (repaired too long or too short). This causes taped distances to be longer or shorter than the true distances.

b. Accidental Errors. Accidental errors involve probability and may accumulate in either direction. Usually, these errors are minor and tend to offset each other. Small errors in plumbing cause the principal accidental error. Tapemen should be careful in plumbing over points. When taping in strong winds, they must be especially careful to reduce swinging of the plumb bob. The tapeman does this by keeping the plumb bob close to the ground and shielding the plumb bob as much as possible with his leg.

c. Errors Caused by Blunders. Blunders are major errors made by poorly trained or careless soldiers. A blunder may be an error in any direction. Correct this by remeasuring the distance.

(1) The main blunders made by tapemen are as follows:

- Incorrect exchange of taping pins.
- Errors in reading the tape.
- Omission of the half tape length when two teams are double-taping.
- Loss of a taping pin.
- Failure of front and rear tapemen to compare distance measured.

(2) Blunders are detected and eliminated by strict adherence to correct taping procedures.

2-18. TAPING AT NIGHT

During night operations, three additional men are added to each taping team. One man goes with each tapeman as a light holder. The third man places the taping pin in the ground. When the rear tapeman comes forward to the taping pin, the third man walks the length of the tape and frees the tape from any obstacles. This procedure is repeated for each full or partial tape length. A piece of white cloth may be tied to each end of the tape to help the tapemen follow and locate the tape. Light holders must observe light discipline when using their lights.

2-19. MAINTENANCE OF STEEL TAPES

a. Steel tapes are accurate surveying instruments, and you must handle them with care. Although steel tapes are of durable construction, they can be easily damaged through improper care and use. Never let a vehicle run over a tape.

b. When a steel tape is used, it should be completely removed from its reel and kept straight to prevent kinking or breaking. The tape should never be pulled around an object that will cause a sharp turn in the tape. Care should be taken to avoid jerking or stepping on the tape. Applying tension with a loop in the tape may cause the tape to kink or break. Before applying tension, the tapemen must be sure there are no loops in the tape.

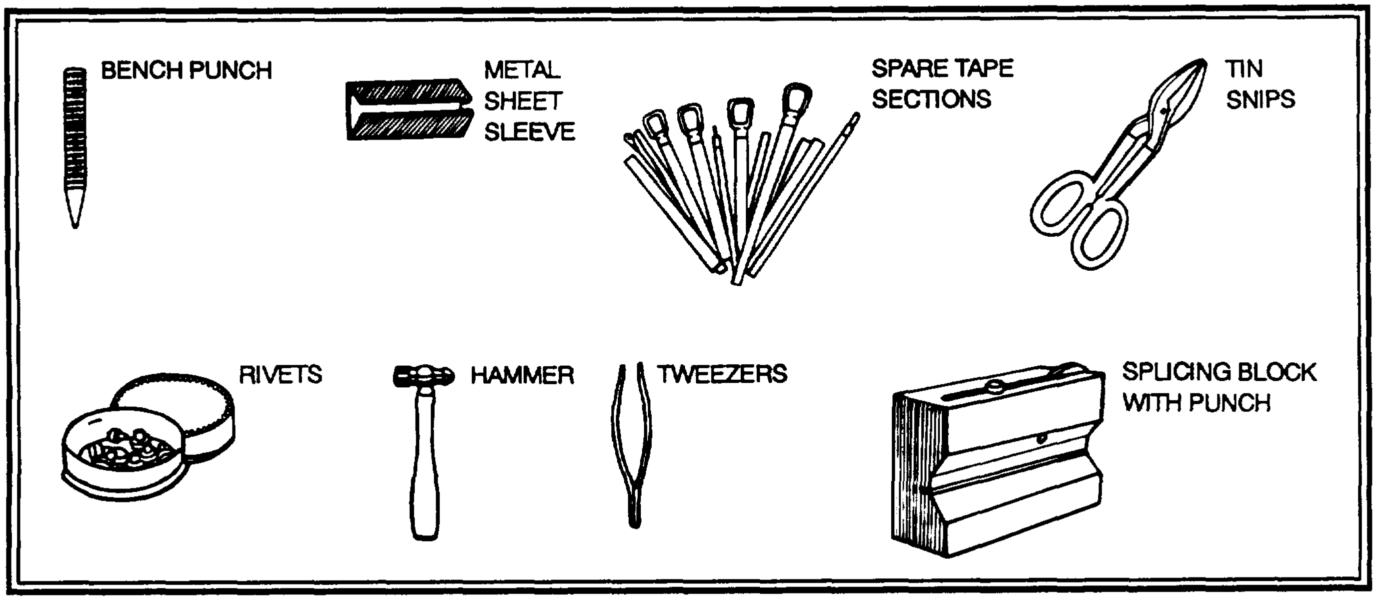
c. The tape should be wiped clean and dry and oiled lightly after each use. The tape is oiled by running it through an oily rag while rewinding the tape on its reel. The tape should be loosely wound on its reel when not in use. When rewinding the tape, the tapeman should insert the end of the tape with the 30-meter graduation into the reel and wind the tape so the numbers are facing the axle of the reel.

2-20. REPAIR OF BROKEN TAPE

a. You can protect tapes and maintain them. However, at one time or another, you may have to repair one in the field to avoid delay in the work. For this reason, every survey party should have a tape repair kit. This kit contains a pair of small snips, tape sections of proper size and graduations, and a hand punch or bench punch with block. Also included are an assortment of small rivets, a small container of sheet metal sleeves, a pair of tweezers, and a small hammer. (See Figure 2-6.) When repairing a broken tape, first square the broken ends. Next, align the broken tape ends over the spare tape section so the graduations are the correct distance apart. Select a spare tape section long enough to span the distance between the squared ends and to overlap each end not less than 3 centimeters. When using rivets, rivet each overlap so the edges of all parts of the points are snug. To do this, place the rivets near (about 3 mm from) the squared ends. A broken tape can also be repaired by fitting a sheet metal sleeve over the broken ends of the tape. The sleeve is coated on the inside with solder and flux. When the sleeve is hammered down tightly and heat is applied, the solder securely binds the broken ends of the tape within the sleeve. You can use an ordinary match to heat the solder. Repair of tapes with rivets is considered a permanent repair. A repair with metal sleeves is considered a temporary repair.

b. Compare the repaired tape with another tape to ensure proper joining of the tape ends and that the tape gives a true measurement. Any discrepancy between the two tapes is recorded in the taping notebook and is referenced to the tape number mentioned earlier.

Figure 2-6. **30-meter steel tape repair kit**



*Section II

SURVEY EQUIPMENT, DISTANCE-MEASURING, ELECTRONIC (MEDIUM-RANGE)

Survey sections equipped with the SEDME-MR can measure distances in minimum time. The SEDME-MR is a compact, lightweight, economical, and simple-to-operate instrument that is especially suitable for short- and medium-range survey operations. Measuring distances from 30 to 7,000 meters takes about 18 seconds measuring time under average conditions.

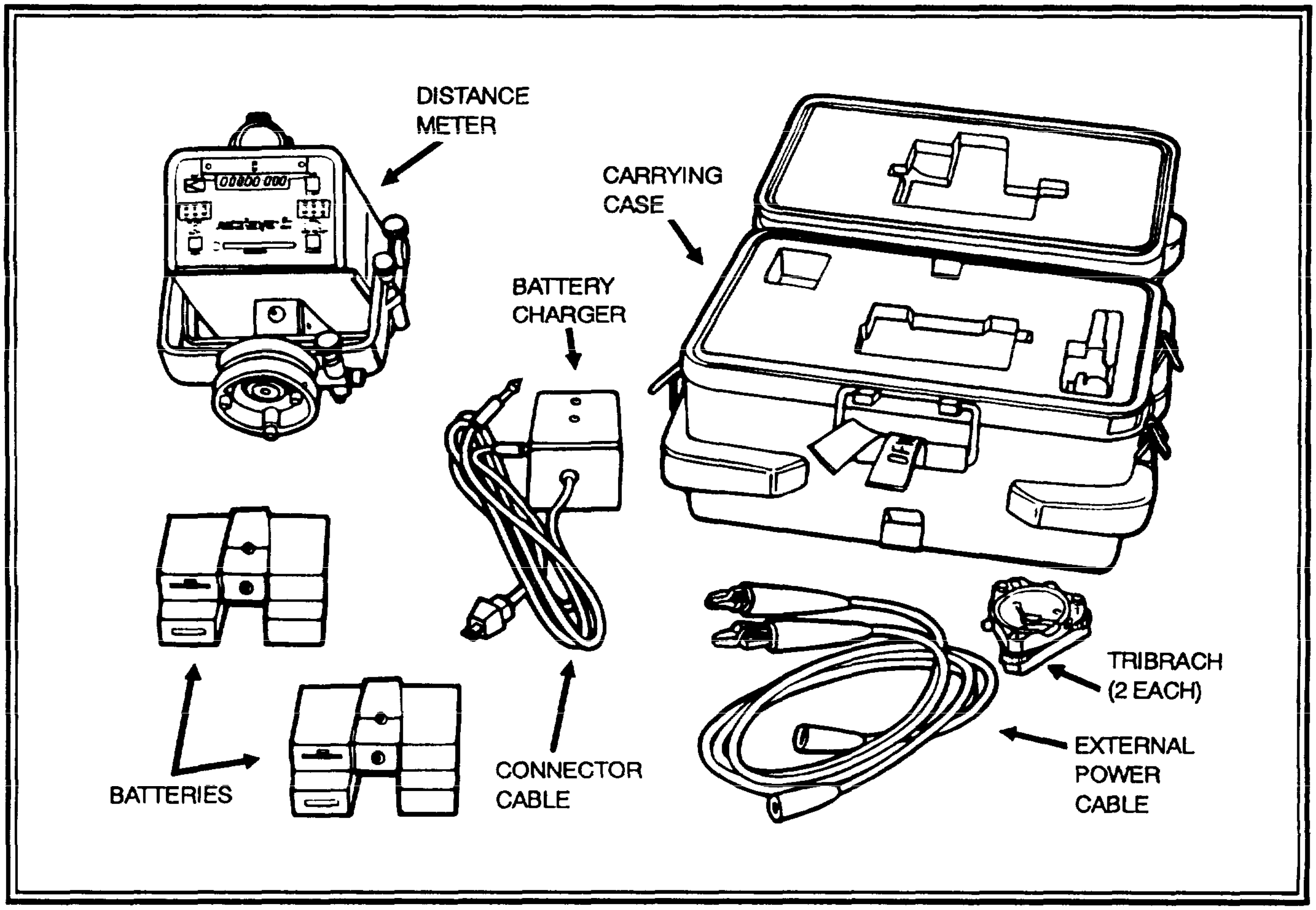
2-21. DESCRIPTION OF COMPONENTS

The SEDME-MR consists of the distance meter and the retroreflector prisms. These units mount on any universal tripod. The distance meter and the retroreflectors are packaged and transported in separate carrying cases—the distance meter case and the restoreflector cases.

a. Distance Meter Case. The distance meter case (Figure 2-7) contains the items of equipment discussed below.

*(1) **Distance meter.*** The distance meter is the electronic package of the system. This instrument generates and sends a modulated signal and receives the reflected signal from

Figure 2-7. **Distance meter case contents**



the prism. The calculated slope distance is in meters and appears on the numerical display.

(2) Batteries. Issued with each system are two nickel-cadmium (NICAD) batteries. You can make about 750 continuous measurements with each battery before recharging is necessary.

(3) Battery charger. A battery charger comes with the system and is used to recharge fully discharged batteries.

(4) Connector cable. The connector cable allows simultaneous charging of both batteries.

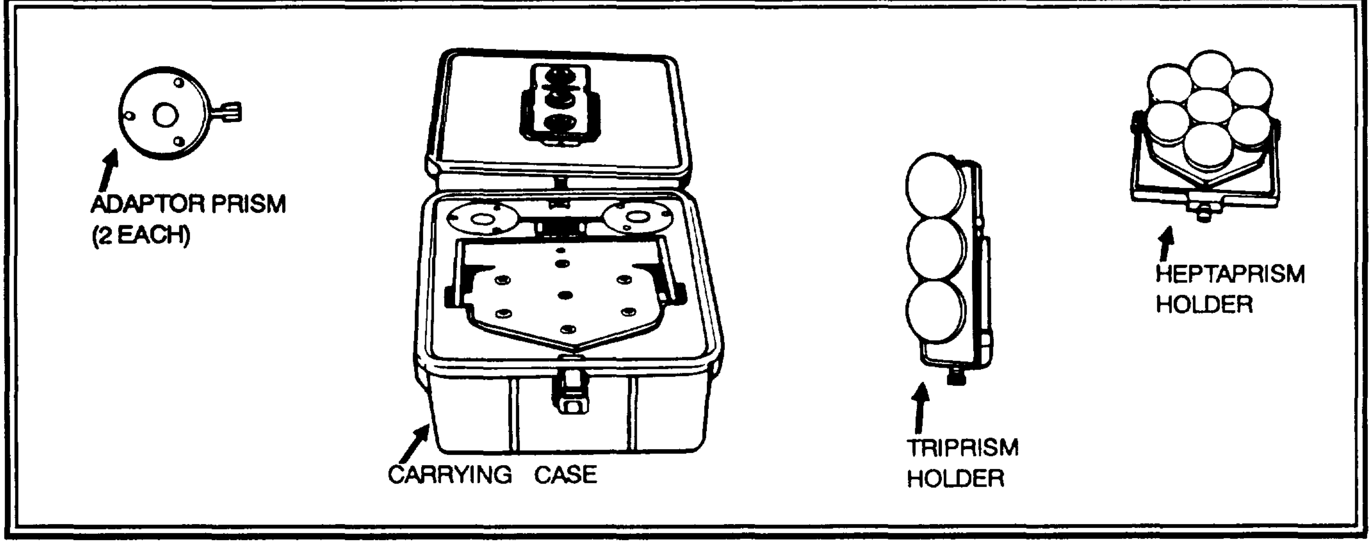
(5) External power cable. The external power cable permits the distance meter to connect to and get power from an external 12-volt battery.

(6) Tribrach. The tribrach adapts the distance meter and retroreflectors to the tripod.

Note. Carrying case design reduces the chance of damage to the instrument and the accessories in transport. Pack all equipment properly in the carrying case before transporting.

b. Retroreflector Case. Two sets of retroreflectors come with each SEDME-MR. A set of retroreflextors consists of a three-prism cluster (triprism) and a seven-prism cluster (heptaprism). (See Figure 2-8.) The triprism is used for distances up to 3,000 meters. The heptaprism normally is enough for a maximum distance of 7,000 meters under average conditions. Average atmospheric conditions are considered to be light haze with visibility of about 15 km or moderate sunlight with light heat waves.

Figure 2-8. **Retroreflector case contents**



2-22. SETTING UP THE SEDME-MR

The setup procedure for the SEDME-MR uses issued tribrachs and/or the theodolite tribrach for the distance meter and prism. After measuring the station angle, follow the steps below. Refer to Figure 2-9 for the location of controls and indicators of the distance meter.

a. Remove the theodolite from the tribrach by using the tribrach clamp. Replace and secure the theodolite in its case.

b. Mount the distance meter on the tribrach and lock it in place by using the tribrach clamp. Check the tribrach leveling bubble, and relevel if necessary.

c. Adjust the vertical lock and horizontal lock firmly enough to allow holding action.

d. When using the NICAD battery, place the battery pack onto the instrument power connector.

e. When using the auxiliary cable, connect the power cable to the power connector. Connect the red clip lead of the power cable to the positive terminal of the 12-volt direct current (v DC) power source, and connect the black clip lead to the negative terminal of the DC power source.

f. Set the parts per million (PPM) switches to 00 (atmospheric correction not used in artillery survey).

g. Set the OFFSET switch to the instrument offset correction. (An instrument offset correction is stamped onto the instrument offset plaque located at the bottom left corner of the instrument.)

h. Accurately set the retroreflector up over the point to which you are making the distance measurement. Align the retroreflector on the line of sight to the instrument. (See Figure 2-10.)

2-23. OPERATING PROCEDURES

a. Test. An automatic test function is built into the instrument. The test provides a quick check of the internal microcomputer and display circuits. To test, press the PWR switch to turn on the instrument. The instrument enters the test mode automatically. The numerical display should sequence from all 0s to all 9s and then display 0000.

Figure 2-9. **SEDME-MR controls and indicators**

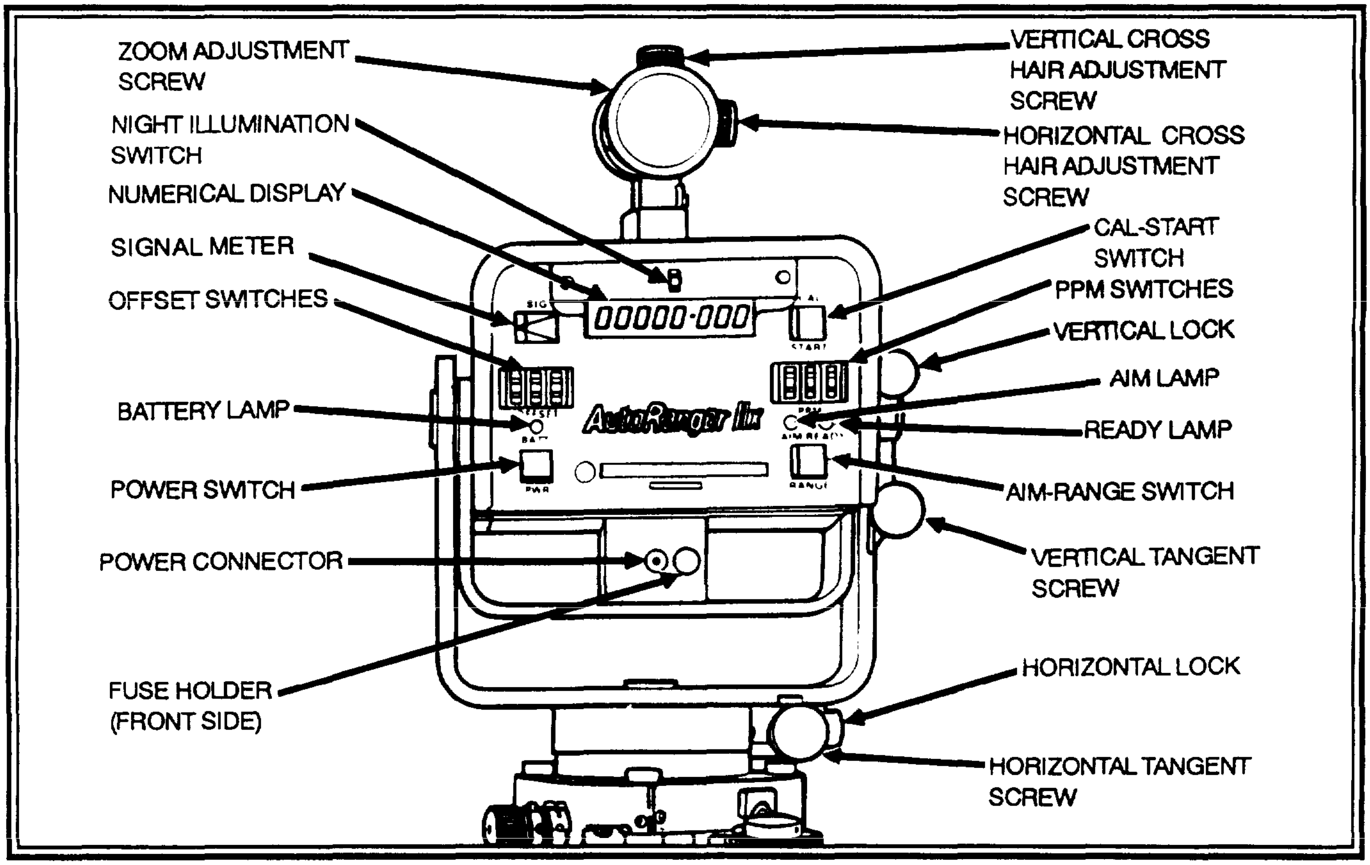
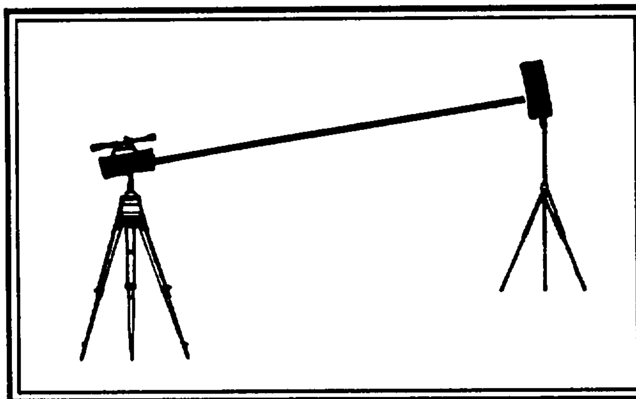


Figure 2-10. **Prism alignment**



b. Retroreflector Acquisition. After completion of the test function, the SEDME-MR is ready for alignment on the retroreflector.

> **CAUTION**
>
> Do not aim the SEDME-MR directly at the sun. The optical system of the SEDME-MR is designed for infinity focus. You may damage the sensitive detector located at the focal point of the receiver optics.

(1) Using the vertical and horizontal tangent screws, position the sighting scope reticle on the prism. For shorter distances, the sighting point should be 4.5 inches above the retroreflector. When the retroreflector is first acquired and a return signal is received, an audio tone will sound for about 2 seconds and then go off. The audio tone will sound again each time the return signal falls below a predetermined level after initial acquisition.

(2) While squiring the retroreflector, note the indication on the signal (SIG) meter. Carefully adjust the vertical and horizontal tangent screws to maximize the SIG meter indication.

(3) If the pointer of the SIG meter runs up against the upper stop because the signal level is too great, press the CAL-START switch. The READY lamp should light, and the meter pointer should automatically move to about midscale before the vertical and horizontal tangent screws are adjusted further. Near the maximum range of the instrument, the meter pointer may indicate below center; however, if the READY lamp is on, measurements can be made.

(4) Repeat steps (2) and (3) above until the SIG meter indicates no further increase.

> **Note.** To achieve maximum range accuracy, correctly sight the Instrument on the retroreflector.

(5) As the last step in the acquisition procedure, press the CAL-START switch and wait for the READY light to come on. When the READY light comes on, the SEDME-MR is ready for distance measurement.

c. Ranging. After sighting the instrument on the retroreflector and maximizing the return signal, the operator performs the steps below.

(1) Press the AIM-RANGE switch. Be very careful not to move the instrument. The AIM light should go out. The SEDME-MR will begin to cycle automatically. A slight clicking sound will indicate that the measurement is occurring. In about 6 seconds, the measured distance will appear on the numerical display.

(2) Read aloud the displayed distance to the recorder. Ensure the recorder reads back the distance correctly. If the recorder repeats the distance incorrectly, immediately announce **CORRECTION** and repeat the correct distance measurement.

(3) The instrument will continue to make distance measurements automatically and will update the range indication on the numerical display every 6 seconds as long as the instrument remains in the range mode. Read and record two more distance measurements.

(4) Check the recorded distances to be sure that there is no variation among the three readings of more than 0.010 meter from the mean. If any of the readings is outside this limit, take another reading to replace it.

(5) To stop the range sequence, press the AIM-RANGE switch to select the aim mode or press the PWR switch to turn off the instrument.

> **Note.** The audio tone will not function in the range mode of operation.

d. Slope Distance Conversion. The mean of the three distances is a slope distance and must be converted to a horizontal distance. There are two different means of converting the slope distance to a horizontal distance.

(1) To compute the required distance, use the formula D = cos V x S. In this formula, D is horizontal distance, V is the vertical angle between the distance meter and the

reflector, and S is slope distance. These computations may be made with logarithms or with the BUCS. The horizontal distance determined from this computation meets the accuracy requirements for field artillery.

(2) The horizontal distance can also be determined by using Program 2 (Traverse) of the BUCS survey module and DA Form 5591-R (Computation of Coordinates and Heights From Azimuth, Distance, and Vertical Angle (BUCS)). (A reproducible copy of this form is at the back of this book.) When using the BUCS to convert the distance, perform the following steps:

Step 1. Call Program 2.

Step 2. Press the END LINE key at the TRAVERSE prompt.

Step 3. Bypass the E OCC STA: 0.00 prompt by pressing the END LINE key.

Step 4. Bypass the N OCC STA: 0.00 prompt by pressing the END LINE key.

Step 5. Bypass the HT OCC STA. 0.0 prompt by pressing the END LINE key.

Step 6. Bypass the AZ TO REAR: 0.000 prompt by pressing the END LINE key.

Step 7. Respond to the prompt MN SCH LEG (Y/N) by entering Y or N.

Step 8. Bypass the prompt HZ FWD: 0.000 by pressing the END LINE key.

Step 9. At the prompt VA (+/-): 0.000, enter the vertical angle.

Step 10. Respond to the prompt RECIP VA (Y/N) by entering Y or N.

Step 11. At the prompt ˆDIST FWD (-:SL/+:HZ), press the END LINE key. When the screen becomes blank, enter the slope distance. Remember to enter the distance as a negative number.

Step 12. At the next step, BUCS will display the horizontal distance.

2-24. CARE AND MAINTENANCE

a. Packing and Transporting. Pack the SEDME-MR in the molded carrying case with the foam inserts provided. The SEDM-MR should be packed for transport or when it is not in use.

b. Condensation. Taking an instrument from a cold to a warm environment can cause condensation on the instrument. Leave the instrument in its carrying case for several hours under such conditions. This allows a gradual temperature change.

c. Lens Care. Use care in cleaning dust or moisture from lenses. Do not touch lenses with fingers. Do not use coarse cloth, paper, or other material that might scratch the lenses. Use antistatic optical cleaning cloth, lens tissue, and a camel‘s-hair brush. Use a mild soap and water solution to remove smudge marks, when needed. To further protect lens, keep lens cover on when not in use.

d. Nickel-Cadmium Battery. A NICAD battery was selected for use in the power unit. A NICAD battery, with proper care, performs good over an extended lifetime. To charge the battery, follow the instructions in (1) through (5) below.

CAUTION

Do not try to charge a battery that is not fully discharged. Ensure each battery is fully discharged by using it until a distance can no longer be measured due to the lack of power. Trying to charge a partially charged NICAD battery will shorten the life of the battery.

(1) Plug the battery charger into an alternating current (AC) power outlet that is continuously supplied with power. The battery charger is designed to operate from a nominal 110-volt, 50/60-hertz (Hz) power supply. When only a 220-volt, 50/60-Hz source is available, use the 220/110-volt adapter supplied with the unit.

CAUTION

Before plugging the battery charger into an AC power outlet, make certain that the rating of the battery charger matches the rating of the available AC power source.

(2) Plug the connector end of the battery charger cable into the power connector unit. On a battery charger that has a red charge light, the light should come on. This indicates that the unit is taking a charge.

(3) Allow about 16 hours to completely recharge a fully discharged battery with the supplied battery charger.

(4) Leaving the battery unit plugged into the battery charger will not cause overcharging. However, during prolonged periods of inactivity, disconnect the charged battery from the power unit and store it.

(5) To prevent possible damage to the NICAD battery, never charge it in an area where the temperature falls below 5 degrees Celsius (C) (40 degrees Fahrenheit [F]) or exceeds 27°C (90°F).

> **Note.** While the battery unit is charging, the battery charger may become warm to the touch and may emit a buzzing sound. This is normal. It is not an indication of a malfunction In the battery charger.

e. Sighting Telescope Alignment. Adjust the alignment of the sighting telescope as discussed below.

(1) Place a single-prism or triple-prism cluster with only the center prism uncovered at a distance of 30 to 50 meters from the SEDME-MR.

(2) Using the vertical and horizontal tangent screws, position the telescope cross hairs on the center of the uncovered prism.

(3) Turn the instrument power on, and select the aim mode. If there is no signal indication, search the area near the prism until the signal is squired. Use the tangent screws to maximize the signal.

(4) Remove the covers from the vertical and horizontal cross hair adjustment screws.

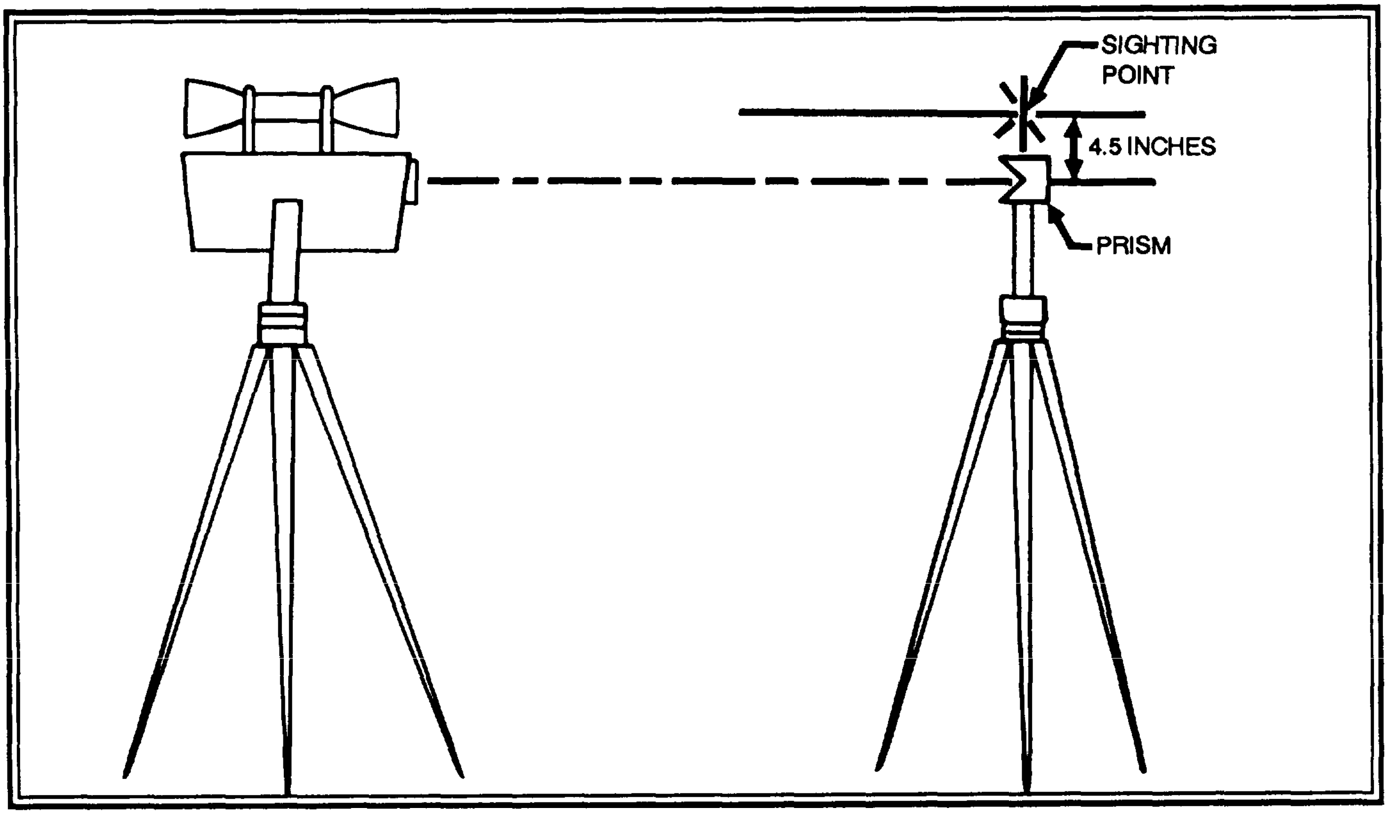
(5) Using the horizontal adjustment screw, position the vertical cross hair to the center of the prism.

(6) Using the vertical adjustment screw, move the horizontal cross hair to a point 4.5 inches above the center of the prism. (See Figure 2-11.)

(7) After adjustments, use the tangent screws to obtain maximum strength and ensure proper alignment. Replace covers on the adjustment screws.

f. Power Fuse. The power fuse protects the power circuits of the SEDME-MR against overload. If the power fuse fails, power is no longer applied to the internal circuits. If you see no response when operating the PWR switch, check or replace the fuse. If repeated fuse failures occur, turn the SEDME-MR in for repair.

Figure 2-11. Telescope alignment



g. BATT Light. Flashing of the BATT light indicates a low battery. The instrument operator can still make reliable range measurements with the light flashing. However, the instrument will go into an automatic power-off mode when battery voltage falls below a preset limit. At that point, the BATT light will glow brightly and steadily. Connection of a recharged battery unit or an auxiliary source to the instrument will permit resumption of normal operation.

Note. In low ambient light conditions, a faint glow may be observed. This is normal end does not indicate low battery voltage.